

WHAT IS CLAIMED IS:

- 1 1. A method of forming a multiple-thickness oxide layer on a silicon
2 substrate, the method comprising:
3 a) forming a sacrificial oxide layer on the silicon substrate;
4 b) patterning an implant mask layer on the silicon substrate to expose
5 a selected first portion of the silicon substrate;
6 c) implanting oxygen into the selected first portion of the silicon
7 substrate through the sacrificial oxide layer;
8 d) stripping the implant mask layer from the silicon substrate;
9 e) stripping the sacrificial oxide layer; and
10 f) growing an oxide layer on the silicon substrate, the oxide layer
11 having an oxygen-implanted oxide region and a non-implanted oxide region.
- 1 2. The method of claim 1 wherein the non-implanted oxide region is
2 less than about 30 Å thick.
- 1 3. The method of claim 1 wherein the oxygen is implanted in step (c)
2 to a concentration of less than about $10^{17}/\text{cm}^2$.
- 1 4. The method of claim 1 wherein the oxygen is implanted in step (c)
2 to a concentration of between about $5\text{E}15$ - $1\text{E}16/\text{cm}^2$.
- 1 5. A method of forming a multiple-thickness oxide layer on a silicon
2 substrate, the method comprising:
3 a) growing a gate oxide layer on a silicon substrate;
4 b) forming a polysilicon layer on the gate oxide layer;
5 c) patterning an implant mask layer on the polysilicon layer;
6 d) implanting oxygen through the polysilicon layer;
7 e) stripping the implant mask layer from the substrate; and
8 f) annealing the substrate to form a thicker gate oxide region of the
9 gate oxide layer, the thicker gate oxide region being oxygen-implanted oxide.
- 1 6. The method of claim 5 wherein the gate oxide layer is less than
2 about 30 Å thick immediately after step (a).

1 7. A method of forming a multiple-thickness oxide layer on a silicon
2 substrate, the method comprising:
3 a) forming a sacrificial oxide layer on the silicon substrate;
4 b) patterning an implant mask layer on the silicon substrate to expose
5 a selected first portion of the silicon substrate;
6 c) implanting oxygen into the selected first portion of the silicon
7 substrate through the sacrificial oxide layer;
8 d) stripping the implant mask layer from the silicon substrate;
9 e) stripping the sacrificial oxide layer; and
10 f) growing an oxide layer on the silicon substrate, the oxide layer
11 being thicker in the oxygen-implanted oxide region in the selected first portion.

1 8. The method of claim 7 wherein the oxide thickness varies from
2 about 30 Å to about 50 Å.

1 9. The method of claim 7 wherein step c) includes implanting oxygen
2 into a second portion of the silicon substrate under the implant mask layer, the oxygen
3 concentration in the second portion being less than the oxygen concentration in the first
4 portion, and the oxide layer over the first portion being thicker than the oxide layer over
5 the second portion.

1 10. The method of claim 9 wherein the oxide thickness varies from
2 about 30 Å to about 50 Å.

1 11. The method of claim 10 wherein the oxygen is implanted in the
2 first portion to a concentration of about 1×10^{16} atoms cm^{-2} and the oxygen is implanted
3 in the second portion to a concentration of about 5×10^{15} atoms cm^{-2} .

1 12. The method of claim 11 wherein the oxide thickness is about 50 Å
2 over the first portion, about 40 Å over the second portion, and about 30 Å where oxygen
3 is not implanted.

1 13. A method of forming a multiple-thickness oxide layer on a silicon
2 substrate, the method comprising:

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- 3 a) forming a high dielectric contrast dielectric layer on a silicon
4 substrate;
5 b) forming a polysilicon layer on the dielectric layer;
6 c) patterning an implant mask layer on the polysilicon layer;
7 d) implanting oxygen through the polysilicon layer;
8 e) stripping the implant mask layer from the substrate; and
9 f) annealing the substrate to form an interfacial oxide layer under the
10 dielectric layer. ~~A~~

1 14. The method of claim 13 wherein the dielectric layer is selected
2 from the group consisting of silicon nitride, zirconium oxide, and hafnium silicate.

1 15. The method of claim 13 wherein the interfacial oxide layer is less
2 than 2 nm in thickness.

1 ~~Sub A~~ 16. A semiconductor device having a gate oxide of multiple thickness,
2 the semiconductor device comprising:
3 a first gate oxide region having a first thickness, and
4 a second gate oxide region having a second thickness, the second gate
5 oxide region being oxygen-implanted oxide, the second thickness being greater than the
6 first thickness.

1 17. The semiconductor device of claim 16 wherein the first thickness is
2 less than about 30 Å.

1 18. The semiconductor device of claim 16 wherein the first thickness is
2 less than the second thickness by less than about 20 Å.

1 19. The semiconductor device of claim 16 wherein the first gate oxide
2 region is non-implanted oxide.

1 20. The semiconductor device of claim 16, wherein the first gate oxide
2 is oxygen implanted oxide, the implanted oxygen concentration being less than the
3 implanted oxygen concentration of the second gate oxide region.